

In situ simultaneous SEM/STEM observation of Pt/C catalysts in a gaseous atmosphere

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In order to gain fundamental understanding of the degradation mechanisms of Pt/C catalyst, there is an increasing demand on the nanostructural characterization using TEM. We have developed the humid-air supply system in TEM, H-9500 300 kV TEM and we have success the deterioration mechanism of fuel cell electrocatalyst¹. Recently, we developed in situ simultaneous SEM/STEM observation technique for surface analysis of catalyst materials using a HF-3300 Cold-FE TEM with SEM/STEM function. We succeeded in visualizing of three-dimensional movement of the Pt particles on the carbon support in the gas atmosphere by this observation technique.

In situ simultaneous SEM/STEM observation of the platinum catalysts on carbon support (Pt/C; Pt: 29 wt.%) in the air conditions were carried out using HF-3300 equipped with the Cold-FE gun and the SEM/STEM function. A gas injection-heating specimen holder² was used for the Pt/C powder heating and gas injection. Pt/C powder mounted on the tungsten wire was heated to 200 deg C in a TEM, and then, while air was spraying (up to 1.2×10^{-2} Pa) from the injection nozzle to the Pt/C, the behavior of the Pt/C was recorded as the movie file. After the air injection at about 1.0×10^{-3} Pa, the coalescence growth between Pt particles on the carbon support was observed, and the Pt particles gradually started inserting into the carbon support. After that, most all of the Pt particles on the carbon support disappeared from the surface of the carbon support. And the carbon support structure was changing into a porous morphology.

We can observe that the behavior of the Pt particles on the carbon support was penetrated into the carbon support by in situ simultaneous SEM/STEM observation. These results demonstrate that the penetration of Pt particles to carbon support affects the degradation mechanism of a Pt/C electrocatalyst.

1. T. Yaguchi et. al., Journal of Electron Microscopy 60(3), 217?225, (2011)
2. T. Kamino et. al., Journal of Electron Microscopy 54(6), 497?503, (2005)

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